ON THE BILOELA LABYRINTHODONT

(SECOND NOTICE.)

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(PLATE XIV.)

In the former paper some general statements were made as to the date of the Hawkesbury rocks, and the atmospheric or climatic conditions under which they were deposited; and it is possible that the subject may not require reiteration of similar arguments. Nevertheless, as a preliminary to a more extended examination into the evidence for the identification of their homotaxis with Indian, S. African, Northern Asiatic, European and American rocks, which has been worked up by, among others, the geologists of the Indian Survey, it may be well to recapitulate what we know ourselves of the sequence in N. S. Wales. And I should venture to say that it is out of the question here to argue as to the position of the Upper Marine Beds. I shall assume them to be, as generally admitted, Carboniferous, containing as they do fossils of the following genera:—*Zaphrentis*, *Palæaster*, *Productus*, *Spirifer* (7 sp.), *Pterinea*, *Aphanaia*, *Aviculopecten*, *Conularia*, *Euomphalus*, *Murchisonia*, *Orthoceras*.

But the Newcastle coal series, in which no evidence is afforded by marine fossils, the beds being entirely of land or fresh-water origin, can hardly be said to have had its homotaxial position ascertained with an equal degree of certainty. Driven to the fossilised plants of this formation for such probable testimony as they may yield, in the absence of the less ambiguous marine fauna, we observe:—First: That *Lepidodendron* and other unmistakably carboniferous types are absent. Secondly—That in the plant beds which underlie the strata containing the abovementioned marine carboniferous fauna, and which, therefore, may claim palæozoic age, we have *Glossopteris Browniana*, which reappears in the Newcastle beds, but no higher; and *G. primæva*, *G. Clarkei*, and *G. elegans*, which do not survive, but are replaced by *G. linearis*, *G. ampla*, *G. reticulum*, *G. cordata*, *G. tæniopteroides*, *G. Wilkinsonii*, and *G. parallela*. The lower beds also contain *Nœggerathiopsis prisca*, and *Annularia australis*; the upper *N. spathulata* and *N. media*. Of these *Annularia*, *Phyllotheca*, and *Vertebraria*, appear also in the Newcastle upper coal (or Permian) beds, with many other species, including Conifers. A ganoid fish, *Urosthenes*, is associated with them in the same beds. The natural conclusion then will be that this Upper Coal is really of Permian age, at least in the homotaxial sense.

This conclusion is corroborated by an examination of the overlying Hawkesbury beds, whose Triassic character has been frequently pointed out by the Indian geologists, and seems to have been finally acquiesced in by the late Rev. W. B. Clarke, who had previously regarded them with the Wianamatta above, and the Newcastle Beds below, as really Upper Carboniferous. (Southern Gold Fields, p. 246 sqq.). With reference to this point we observe—First, that the Newcastle Beds, belonging to the (Permian? or) Upper Coal measures, had undergone considerable denudation before the commencement of the deposition of the Hawkesbury Sandstone, as Mr. Wilkinson has shown from a section upon the falls of the Shoalhaven, and as I have myself observed at Lake Macquarie, so that an interval of some length is here indicated, though its duration cannot at present be more than guessed at. Yet after a careful consideration of the very scanty information which is supplied us by the rare and imperfectly preserved fossils of the Hawkesbury formation, most geologists will probably agree with Mr. Wilkinson in arranging it, homotaxially at least, with the Triassic of other regions. For the characteristic plants of the Newcastle Coal Measures have disappeared. We find no more *Glossopteris* nor *Vertebraria*. But we find in their place a large and robust fern, if fern it be, *Thinnfeldia odontopteroides*, which is common to both Hawkesbury and Wianamatta, *Ottelia præterita*, a large water plant with fenestrated leaves from the Parramatta River, Unionidæ, a huge *Planorbis* (?) &c., &c, which seem to indicate a much later period, together with *Palæoniscus* and *Cleithrolepis* in the Wianamatta, or uppermost beds of the series. (Note 2). The presence of *Macrotæniopteris* is certainly in favour of the Jurassic age of the Wianamatta, but that of *Palæoniscus* would seem to out-weigh it in favour of the Triassic.

The evidence, however, taken all together, formed a strong ground for this hypothetical arrangement, which is now almost established by the discovery, in the middle of the formation, of the Labyrinthodont fossil figured in Plate XIV.

It is plain, from what has been stated, that if the Newcastle beds are Permian, the Hawkesbury are probably Triassic. But we cannot check this conclusion by an examination of the overlying beds. For at least on this side of the main range, neither the supposed Permian, nor the supposed Triassic, *i.e.*, neither the upper coal measures nor the Hawkesbury and Wianamatta have ever been subject to submergence or marine erosion, except exactly along the line which from time to time has formed the eastern coast of the continent. But they have undergone enormous sub-aerial denudation, the records of which may—to some extent—be read in the gorges of the Blue Mountains. It may be that the Clarence River beds are Jurassic, yet since they are entirely of fresh-water origin, it is difficult, with our present scanty knowledge, to correlate them with certainty. The cretaceous formation north of the Darling is the first, after the upper marine (Upper Carboniferous) beds, to offer the much desired evidence which a marine fauna alone can supply.

In Mr. Miall's report upon the Labyrinthodonts, (British Association, 1873), we have genera recorded from the Trias in the northern hemisphere as follows:—Europe, *Capitosaurus*, *Chaliosaurus*, *Diadetognathus*, *Labyrinthodon*, *Mastodonsaurus*, *Melosaurus*, *Metopias*, *Trematosaurus*, *Xestorrhytias*; Central India—*Brachyops*, *Gonioglyptus*, *Pachygonia*; South Africa—*Micropholis*; Australia—*Bothriceps*. The Triassic forms in the New World all belong to the northern hemisphere, and are *Dictyocephalus*, *Eupelor*, *Pariostegus*. To these forms Mr. Lydekker (Palæontologia Indica, Ser. IV. Vol. I. Part 4), has added *Gondwanosaurus*, the Labyrinthodont from the "Bijori Group," which forms the top of the Damuda, and immediately underlies the Panchets which contain their *Dicynodon*, *Gonioglyptus*, *Pachygonia*, *&c.*, and are probably more or less contemporary with the Mángli group which has yielded *Brachyops laticeps*, (lib. cit. p. 2). Again, in Part 5 of the same volume the same author describes certain *Mastodonsaurus* and *Pachygonia* remains from the Maleri and Denwa Groups, and gives a table of homotaxial affinities, from which I extract the following table :—

Commencing with the Upper Trias (Rhætic and Keuper of Europe) ; Maleri, (Upper Gondwana) of India, and here indicated by the Roman numeral I. we have

I. EUROPE.	I. INDIA.
Belodon.	*Belodon.*
Hyperodapedon	*Hyperodapedon.*
Mastodonsaurus.	*Mastodonsaurus.*
Ceratodus	*Ceratodus.*

Lower down we arrive at the Bunter and Muschelkalk of Europe, the Panchets of India, where we find.

II. EUROPE.	II. INDIA.
Trematosaurus.	*Dicynodon.*
	Pachygonia.
	Gonioglyptus.

It is hardly necessary to observe that *Dicynodon* is a characteristic fossil of the Karoo beds in South Africa ; and, for my own part, I believe that the appearance of this strange and obsolete type was contemporaneous, in India and Africa, within the not excessive limits of one hundred centuries, or ten thousand years, which many and various considerations seem to indicate as the unit of geological time ; (Croll, 'Climate and Time,' *passim*), and that in like manner the *Mastodonsaurus*, *Capitosaurus*, or whatever it may prove to be, certifies the contemporaneity under such wide conditions as have been indicated above, of the rocks seen at Biloela

(Cockatoo Island) and elsewhere on the Eastern Coast of Australia, and known everywhere by the late W. B. Clarke's name of "The Hawkesbury Formation."

Now in this formation, as was stated in the previous note upon the Biloela fossil, there are abundant evidences of the action of drift ice. At the present moment I am not aware of any direct evidence of glacier action. Still the existence of glaciers in the mountainous regions from which the drift is derived must be postulated if we find in the fluviatile deposits unmistakable tokens of glacial action. Since these have been ascertained, we need not argue the question of the possibility of glaciers. But we must at the same time admit that there is no evidence for a *Glacial period* upon the present line of coast of New South Wales. Moreover, it may be boldly asserted that all that we know of the formation of glaciers will lead us to locate them upon the western rather than on the eastern shores of lands, whose climatic or meteorological conditions might otherwise render their formation possible.

However, the evidence as to *Drift ice*, carried down by great rivers in ancient times as now in the present day by the Rhine, the St. Lawrence, and scores of other streams, seems conclusive. In short we may positively say that the Hawkesbury sandstones were deposited during a period in which there were upland glaciers, and tremendous spring and summer floods. There are many regions similarly affected now, and there have been many more, as any student of geology knows.

But at the same time we have to recognize the existence of a warm temperate climate, in which the luxuriant Fern vegetation, Ganoid Fish, Unionidæ, and last, though the most important, large Labyrinthdont Amphibians could exist.

The same phenomena are presented by Triassic strata all over the world, and lead us to the conclusion that the period during which this formation, with all its singular and transitional fauna and flora, was developed, was one during which the earth's orbit was in one of its stages of extreme eccentricity, and the globe itself subjected to extraordinary changes of climate, reciprocating in the alternate hemispheres in such a manner that equable warmth in the Northern or Southern was contemporary with the most extreme inclemency in the opposite.

The particular horizon in which the characteristic fossils may be looked for is, as is shown by the Biloela remains, nearly at sea-level along the coast. It is at the same level that the action of river ice has been detected by Mr. Wilkinson. (Report, &c., 1882, p. 53.) That quantities of fern fragments, with their tissues still woody and elastic, are everywhere to be met with in the intercalated shales; that *Ottelia prœterita,* was found on the shores of the Parramatta River; and that thick beds of ferruginous concretionary sandstone, as seen at all levels, from that of the sea to the heights of Waverley, Randwick, and North Head, are worked for road metal, or gravel, is all evidence to the same effect.

Now if we follow this horizon to the westward, we observe the strata dipping towards the Nepean fault, at a small angle, indeed, but unmistakably. From the first slope of the ascent of the Blue Mountains, where the still incoherent sands have been bent downwards towards the East, without other disturbance than that caused by the necessary sliding of bed over bed, and certainly before their consolidation into what is ordinarily known as rock, we find a continual rise to the westward; reaching at last its culmination in the unabraded summit levels of sandstone which have been protected from erosion by the basalt of Mount Tomah, Mount Wilson, Mount King George, and Mount Hay. At Mount Piddington, near Mount Victoria, we find *Thinnfeldia*, and likewise evidences of ice, in abundance. There too, and more particularly at Katoomba, we find the ferruginous quartz conglomerate, which is repeated in identical form in Clark Island in Port Jackson, and elsewhere on the coast.

This I take to be the horizon of the fossiliferous beds of Biloela, and it is along this plane that I should expect that more important discoveries will yet be made.

Nothing however can now upset the identification of our Hawkesbury (and probably Wianamatta) beds with the Trias of Europe and India.

I cannot refrain in conclusion from again expressing my conviction that Homotaxial relations do often imply contemporaneity—not always certainly, nor we may say, *ever* in recent periods, but the more frequently the further we go back into the remoter antiquity. And I must add that I do not think that an interval of 10,000 years between one formation and another should be considered as a break in that loose co-ordination of dates which we call Geological Time.

I may here observe, in conclusion, that the former paper upon this subject was written away from Sydney, and without the proper books, but from notes which turn out to have been in some parts imperfectly made. For instance, p. 934, in adopting Quenstedt's reference of *Capitosaurus*, Münster, back to *Mastodonsaurus*, Jäger, I was flying directly in the teeth of the Report of 1874, which I had nevertheless read, and ought to have better digested. For here (p. 154) *C. robustus*, van Meyer, is described, with the caution that the shields in Quenstedt's plate cannot as yet be accurately determined. They are however, mentioned (ibid.) as follows:—"Median plate rhomboidal with rounded entering angles; lateral plate not produced backwards, with strong reflected process; radiately sculptured."

The formations which in New Zealand correspond to the Newcastle (Permian) and Hawkesbury (Triassic) of New South Wales, are the Kaihiku for the former, and the Oreti, Wairoa and Otapiri series for the latter (Hector, N.Z. Handbook, 1870, p. 24). They are of enormous thickness, from 12,000 to 15,000 feet if taken together, and are principally marine, though Plant-beds containing *Glossopteris*, &c., occur both at the base of the Kaihiku and at various horizons in the later formations. Rough and heavy conglomerates and breccias repeat the characters observed in the Permian and Trias in India (ib. l.c.) and elsewhere; and the most striking variation from them is found in the great thickness of the New Zealand beds. It is obvious that they also differ from their homotaxial equivalents in Australia by their largely marine origin. This opens a way to interesting speculations on the geological history of both countries, which, however, must be passed for the present. I mention the subject here only to note that in New Zealand also, as well as in New South Wales, Labyrinthodont remains have been found, as in the Kaihiku, at Nugget Point, Otago, and in the Otapiri, in the Wairoa district; and that the great *Eosaurus* (?) of Mount Potts, so bulky that in some vertebræ the centrum is 18 inches in diameter, is also referred, though with some hesitation, to the same order (Hector l.c.).

Note 1.—After the preceding paper had been read, on November 30, I received a note from Mr. Wilkinson informing me of the discovery of a 'Baby Labyrinthodont' in the railway excavations, near Gosford. Two other Labyrinthodont fossils have also turned up from the Wianamatta at Bowral. The first however is from one of the intercalated shales of the upper portion of the Hawkesbury sandstones, and not in the higher Wianamatta beds.

These help to mark the horizon, upon which such remains may be sought for with good hope of success, as that of the upper and irregularly bedded portion of the Hawkesbury, and the lower beds of the Wianamatta formation; contemporary, it may be, with an early stage of the basaltic eruptions which have formed the rich lands of the Upper Nepean and Wingeecarribee, and have also intersected with a net work of dykes and small cones of volcanic rock the whole valley of the Nepean from Razorback to Pennant Hills. The shales are certainly younger than some of the igneous rocks of the district, and older than others, as is shown from the instance of Prospect Hill by the late Wm. Clarke (Sedimentary Formations, p. 73), so that the whole region must have been subject to volcanic outbursts and disturbances during long geological periods (though interrupted probably by intervals of repose), commencing with the close of the Permian, and ultimately dying out in the early Tertiary.

Note 2.—In the piece of rock alluded to in Note 1, *Palæoniscus*, *Cleithrolepis*, and another Ganoid, are associated with the Labyrinthodont. This discovery therefore helps to bind the Wianamatta and Hawkesbury in a still closer sequence than was before generally recognised. But see Rev. T. Woods, P.L.S. N.S.W , Vol. VIII.

Note 3.—Since the preceding paper has been in type, the fossil has been cleared from the matrix in such a manner as to show that it is really a cast or impression of the exterior aspect, and that the interior surface was quite smooth. It follows that its position was upon the left side.

EXPLANATION OF PLATE XIV.

The upper figure represents a specimen from a collection of fossils supplied to the University some years ago, by Dr. Krantz, of Bonn, and bears the label "*Mastodonsaurus robustus*, Qu. ; Keuper sandstein, Gres triassique supérieure, Upper Triassic Sandstone. Loc. Stuttgart." I presume it to be the lateral thoracic plate of the left side, seen from below, with its bony tissue well preserved. The anterior extremity is that towards the left hand, the line along which it met the corresponding plate of the right side being just above the scale of inches, and the exterior angle from which the ribs radiate just below the numerical ticket. The further extension upward towards the right is evidently connected with the plate, but perhaps not actually a portion of it.

The lower figure represents a similar plate from Biloela or Cockatoo Island, Port Jackson. It is apparently a secondary cast in sandstone, the bone having been replaced by the matrix. But if it is a primary cast, presenting a reversed image of the original structure, it must be regarded as belonging to the right side of the animal. The large holes have been formed by pebbles of shale, which had been embedded behind the plate, and, presumably, dropped out during the rough handling of the block in the processes of quarrying. A portion of the bone is still embedded in the matrix towards the upper right hand corner, but I have not ventured to attempt its release, until the specimen has been carefully examined by others.